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Simple functional tests in COPD: stand up and be counted!

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Chronic obstructive pulmonary disease (COPD) is widely recognized as a multisystem disorder (1). Although forced expiratory volume in 1 second (FEV₁) is a widely accepted marker used in the diagnosis and staging of COPD, it tells us very little about extra-pulmonary manifestations, such as skeletal muscle weakness and sarcopenia (2-4), and shares only a weak relationship with patient-centred outcomes of health-related quality of life and exercise capacity (5). Pulmonary rehabilitation, the most effective non-pharmacological intervention in COPD, brings meaningful benefits to the patient, yet has little effect on FEV₁. Hence additional assessment tools are needed to provide a comprehensive picture of disease impact.

Exercise intolerance and functional impairment are commonly reported by patients with COPD. They result from multiple contributing factors including dynamic hyperinflation, increased respiratory load, poor gas exchange, skeletal muscle dysfunction, age-related frailty, physical de-conditioning, mood disturbance, lack of motivation, and comorbidity burden. Physical functioning may therefore reflect the impact of COPD better than FEV₁. Certainly, reduced exercise capacity has been consistently associated with increased mortality (6, 7).

So how best to routinely and objectively assess physical functioning? Laboratory-based cardiopulmonary exercise testing (CPET), typically using cycle ergometer or treadmill, is the physiological gold standard but is time-consuming, requires specialist equipment and expertise, making it impractical for routine use in a busy clinic setting. Field walking tests, such as the 6-minute, incremental and endurance shuttle walk tests, are simpler and cheaper to perform than CPET, and have been readily adopted by the pulmonary

rehabilitation community. Increasing evidence support their validity and responsiveness (8, 9), and technical standards have recently been published (10). However, even these tests may not always be possible to complete in some settings. For example the 6-minute walk test (6MWT) requires a course at least 30 metres, which is rarely feasible in the patient's home or acute hospital bedside.

Recently, there has been growing interest in even simpler functional tests, particularly lower limb physical performance measures, to assess people with chronic respiratory disease (11). Many of these tests have origins in gerontology, for use in large community-based epidemiological studies of older adults where rapid and practical assessment of physical functioning was required in the home setting. Broadly, there are four main groups of simple lower limb physical performance measures: 1) gait speed tests (time to walk a set distance) (12, 13); 2) sit-to-stand (STS) tests, which measure either time taken to stand from a sitting position five times (known as the 5-repetition STS) (14) or the number of sit to stands in a set time (typically 1-minute)(15); 3) step tests (many protocols exist but the best described is the 6-minute step test where people are asked to step up and down as many times as possible in six minutes) (16); and 4) timed up and go (17), which incorporates elements of both gait speed and STS tests.

In this issue of the *European Respiratory Journal*, Crook *et al.* provide a psychometric evaluation of the 1-minute STS test (18). The authors should be congratulated for a comprehensive evaluation, which incorporated assessment of learning effect, test-retest reliability, construct validity, responsiveness and minimal important difference (MID) of the 1-min STS test, using data from two longitudinal studies involving 52 and 203 COPD patients

undergoing pulmonary rehabilitation (18). The 1-min STS test had minimal learning effect (ICC 0.93) with excellent test-retest reliability (ICC 0.99). Both before and after rehabilitation, there was a strong relationship between the 1-min STS and 6MWT, and the 1-min STS test was responsive to rehabilitation. Using anchor and distribution methods, the MID was estimated to be 3 STS manoeuvres when prioritising the anchor-based method. This study corroborates previous data supporting the validity and responsiveness of sit-to-stand tests (14). Jones and colleagues showed similar excellent reliability, validity and responsiveness to pulmonary rehabilitation of the 5-repetition STS, with the authors conservatively estimating the MID to be 1.7 seconds (14).

STS tests have obvious advantages. They require little space, simple equipment (chair and a stopwatch), and would be feasible in all settings including the home, busy clinic setting or the acute hospital bedside. Is there a need for more formal field walking exercise tests or laboratory-based CPET? In a small sub-group, the authors performed the 1-min STS and 6MWT whilst metabolic data were collected to examine physiological responses. End-exercise oxygen uptake, ventilation parameters, respiratory rate and heart rate were similar. This might suggest the 1-min STS is a test of exercise capacity, but really only confirms the concurrent validity of STS and field walking tests as under the umbrella of physical functioning tests. Indeed, fewer patients desaturated during the 1-minute STS and the correlation between change values in the tests from before to after rehabilitation was low ($n=52$: $r=-0.08$, $n=203$: $r=0.21$) indicating the 1-minute STS and 6MWT measure different constructs. Similarly, Jones and colleagues showed only weak relationships between changes in 5-repetition STS and incremental shuttle walk with pulmonary rehabilitation (14).

A limitation of the study (acknowledged by the authors), and of STS tests in general, is the presence of a floor effect. In the study by Crook and colleagues, patients unable to perform five STS manoeuvres were excluded. The number of patients excluded for this reason was not reported, but in a previous study of outpatients attending pulmonary rehabilitation, 15% were unable to meet this threshold (14). Indeed between 9-14% of outpatients are not able to even stand unaided once (19). Therefore only selected, higher functioning patients are able to perform STS tests, excluding those with the poorest functional ability or lower limb impairment. This somewhat limits the advantage of this test as a feasible functional outcome measure in the home-setting or acute hospital bedside, settings where one might expect to find patients with the poorest physical functioning and greatest skeletal muscle dysfunction. In this group, gait speed tests (typically over a short distance such as 4-metres) may provide a better fit to the population of interest (3, 12, 13, 20, 21).

Accepting that STS tests may not measure exercise capacity, and have utility as an outcome measure in only selected patients with COPD, simple functional tests remain helpful to the clinician. As “global” markers of disease impact, they can be used to rapidly stratify patients. For example, outpatients with COPD and “slow” four metre gait speed ($<0.8\text{ms}^{-1}$) have significantly reduced exercise capacity, report higher respiratory disability and worse health related quality of life compared with those with preserved walking speed, despite similar FEV₁ % predicted (13). Gait speed is also widely incorporated into consensus definitions of geriatric syndromes such as sarcopenia and frailty (3, 21, 22). Moreover, in line with the gerontology literature, there is increasing evidence to support the association between functional performance and risk of adverse outcomes in COPD. The 1-min STS has previously been shown to be strongly associated with mortality in COPD with an adjusted hazard ratio

for two-year mortality of 0.58 (95% CI 0.40 to 0.85) for every 5 additional repetitions (23), whilst Kon and colleagues recently demonstrated that the four metre gait speed was not only feasible in patients hospitalised with acute exacerbation of COPD, but also independently predicted hospital readmission in older patients (24). Simple functional tests have been incorporated into the baseline evaluation of several COPD cohort studies (21, 25, 26), and longitudinal prognostic data are anticipated.

Simple functional tests are here to stay, and will become increasingly relevant in COPD and other chronic respiratory diseases, particularly with an ageing population, increasing multi-morbidity and frailty, and more people living with prolonged impairment and disability (21, 22). Well conducted, psychometric studies, such as that described by Crook and colleagues, are important in helping clinicians understand the relevance of test values, and give them greater confidence to incorporate these tests more widely into the routine clinical assessment of their patients.

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